**Annual Report 2005: Geologic Mapping and Database for Portland Area Fault Studies**
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This project seeks to improve understanding of crustal earthquake hazards in the Portland Oregon Urban area by preparing detailed surface and subsurface geologic maps of key areas. The purpose is to build a better geologic model to help locate faults and evaluate their history and earthquake potential. This project is part of a joint USGS-DOGAMI effort to make new detailed surface and subsurface geologic maps of the entire Portland Urban area (Figure 1). The goal of the current (FY 2005) project was:

1. A new 1:24,000 scale geologic map of the Dixie Mtn. quadrangle.
2. Lidar Coverage of the Portland Hills
3. To locate and archival engineering and water well boreholes along the trace of major faults in the area.

## Geologic Mapping

The Dixie Mtn quadrangle is important to Portland area because it straddles the northern end of the Portland Hills and Oatfield faults (Figure 2). Throughout most of the area where these faults have been mapped, they cut Miocene Columbia River Basalt, and are buried by Holocene deposits, providing little insight as to the timing of the obvious deformation of the basalts. In the Oregon City quadrangle that we mapped in FY 2004, these faults appeared to cut younger units with very low slip rates and little topographic expression. In the Dixie Mtn quadrangle the prominent NW trending escarpment of the NE side of the Portland Hills ends, and the projection of the fault extends into the highlands. It was hoped that this would afford an opportunity to map the fault and learn about its history and style in upland exposures, because most of the inferred trace along the strong topographic trend to the SE is buried by culture or young alluvium.

Figure 3 summarizes progress to date on the mapping, which has proved to be a challenge. The key to understanding the structure of the area is to work out the stratigraphy of the Columbia River basalt flows in the area. This is theoretically straightforward, with an excellent stratigraphic framework developed by past workers such as Dr. Marvin Beeson and his colleagues at Portland State University and Dr. Ray Wells and his colleagues at USGS. However, in Dixie Mtn, exposures of basalt are rare. A blanket of loess 10 to 20m thick covers most of the area, and the basalt is severely weathered to depths of 10-60 m. Finding sufficiently fresh samples for hand specimen lithology, chemistry or paleomagnetic measurements is very difficult.

Understanding the structure and geology is further complicated by the presence of widespread large-scale landslides. Along the relatively gentle SW facing slopes in the west half of the map, there are abundant landslides fringing every drainage, which limits the opportunity to see fresh basalt. Virtually the entire NE corner of the map is a gigantic landslide complex covering several square kilometers and moving in a mass over 100m thick. This is precisely the area where we had hoped to trace the Portland Hills fault, and it appears now that the anomalous topography we had initially suspected of being tectonic are instead landslide related.

Additional field work is needed to exhaust all possible sites for basalt sampling, and we have just begun making use of a new GPS-navigated cesium magnetometer to map basalt flow contacts where buried (Figure 4). Location of waters wells and analysis of well logs has provided some insight o the shape of the base of the basalt where it rests on Miocene marine sedimentary rocks, and further work may reveal additional faults.

We have analyzed 29 basalt samples for XRF, and have been fairly successful in placing them in the regional stratigraphy (Table 1). Another 10 are pending. Unfortunately many sites turned out to be in the large landslide area, and are of limited significance.

**Portland Hills Lidar**

Working with the Puget Sound Lidar Consortium (PSLC), USGS staff and TerraPoint Inc. We were able to successfully contract for and acquire a swath of Lidar data that images much of the Portland Hills and downtown Portland. Figure 5 shows the survey area, which dovetails both with and earlier USGS-funded pilot study, and with the FY 2004 USGS Lower Columbia Survey. We have received a provisional copy of the data (Figure 6 shows an example from the Dixie Mtn area, illustrating large landslides) from TerraPoint, and it is currently waiting for Qa/Qc processing at PSLC. This has been held up because PSLC needs to do the processing in concert with the adjacent Lower Columbia Survey, which has only recently been delivered by TerraPoint.

When QA/QC is complete, the Lidar data will be available on the PSLC website for free download, and will be published on CD by DOGAMI.

**Borehole Location**

Using student intern labor, we were able to interpret geology for over 1000 previously located borings along the trace of the Portland Hills Fault (Figure 7). The boring logs are available online, sorted by Township Range and Section, and typically the logs include a street address, taxlot number or map showing their location. Each boring that had adequate location information was plotted in our GIS, and attributed with location and ownership information. We estimated both vertical and horizontal location error and added those estimates to the attributes. Geology was interpreted both on a strictly lithologic basis, using codes for various material types, and also on a stratigraphic basis, using our existing geologic map and model as a guide.

We did not make as much progress as we had hoped on this aspect of the program, because we were only able to have a student available for 4 months. We have just hired a new student, and hope to resume data collection and interpretation shortly.

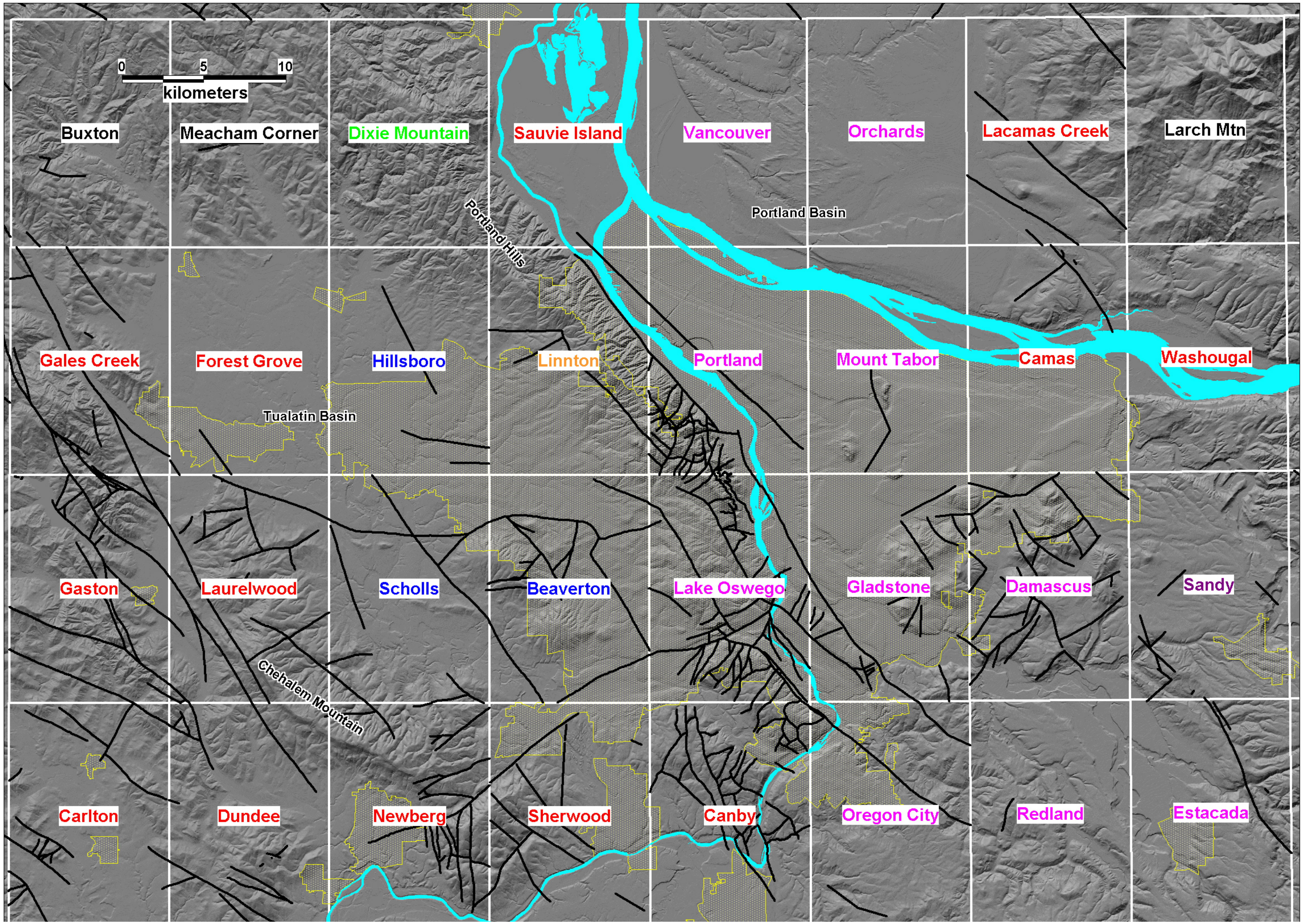


**Figure 1, location map**. Shaded relief map of the Portland Urban area. Yellow lines and shade are Urban Growth Boundaries of local cities; white grid is outline of quadrangles. Quadrangle label colors indicate: red, USGS mapped or in progress; magenta, DOGAMI mapped; blue, DOGAMI surficial map; USGS bedrock mapping in progress; black, unmapped; purple, partially mapped, student thesis; orange, DOGAMI FY 2006 proposal; green DOGAMI FY 2005 mapping. Heavy black lines are mapped faults.

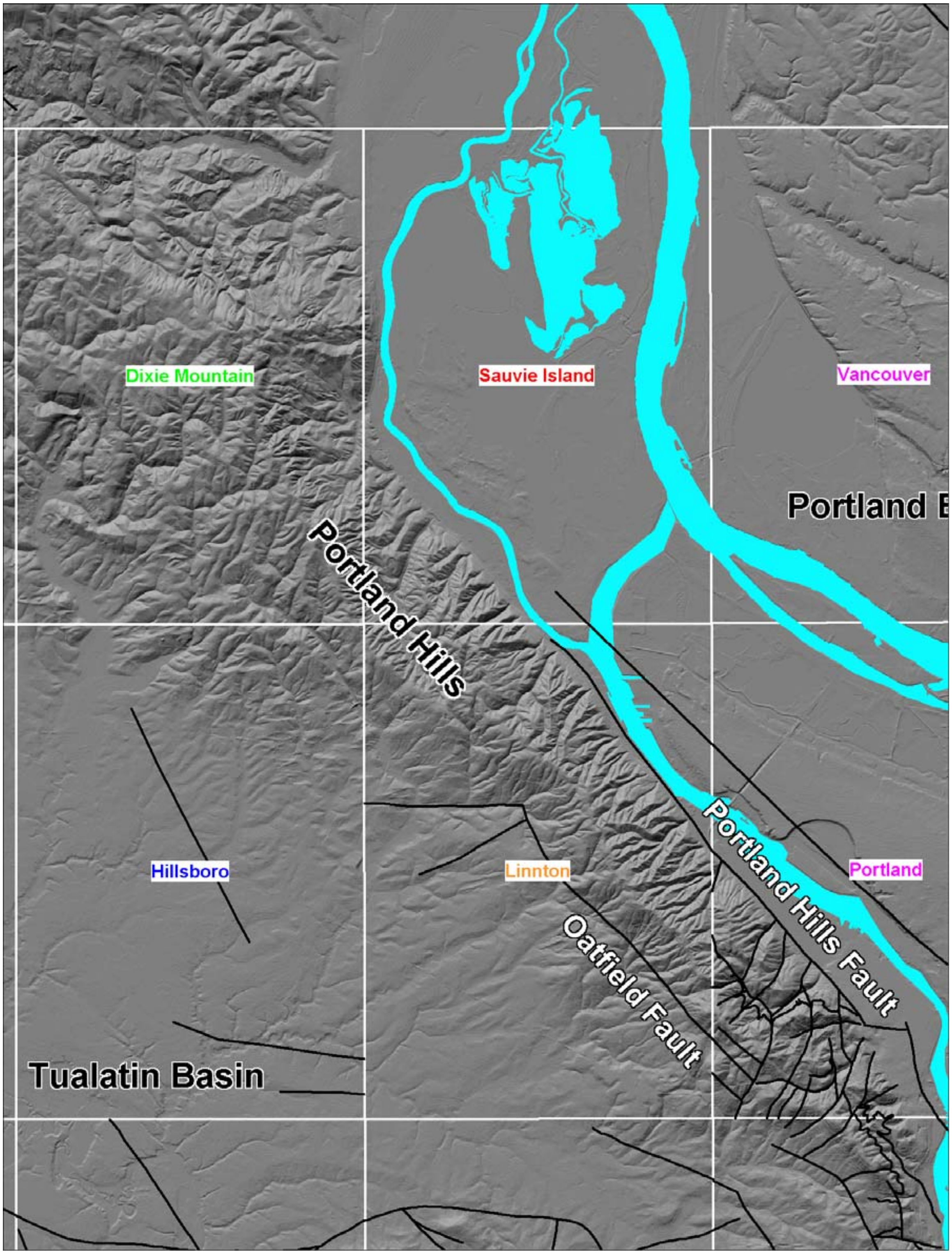

**Figure 2, North end of Portland Hills Fault**. Heavy black lines are mapped faults. Note abrupt change of trend of NE side of Portland Hills that occurs along the east edge of the Dixie Mtn quadrangle. Linear topography in the NE third of the Dixie Mtn quadrangle that is on trend with the Portland Hills fault is landslide related.

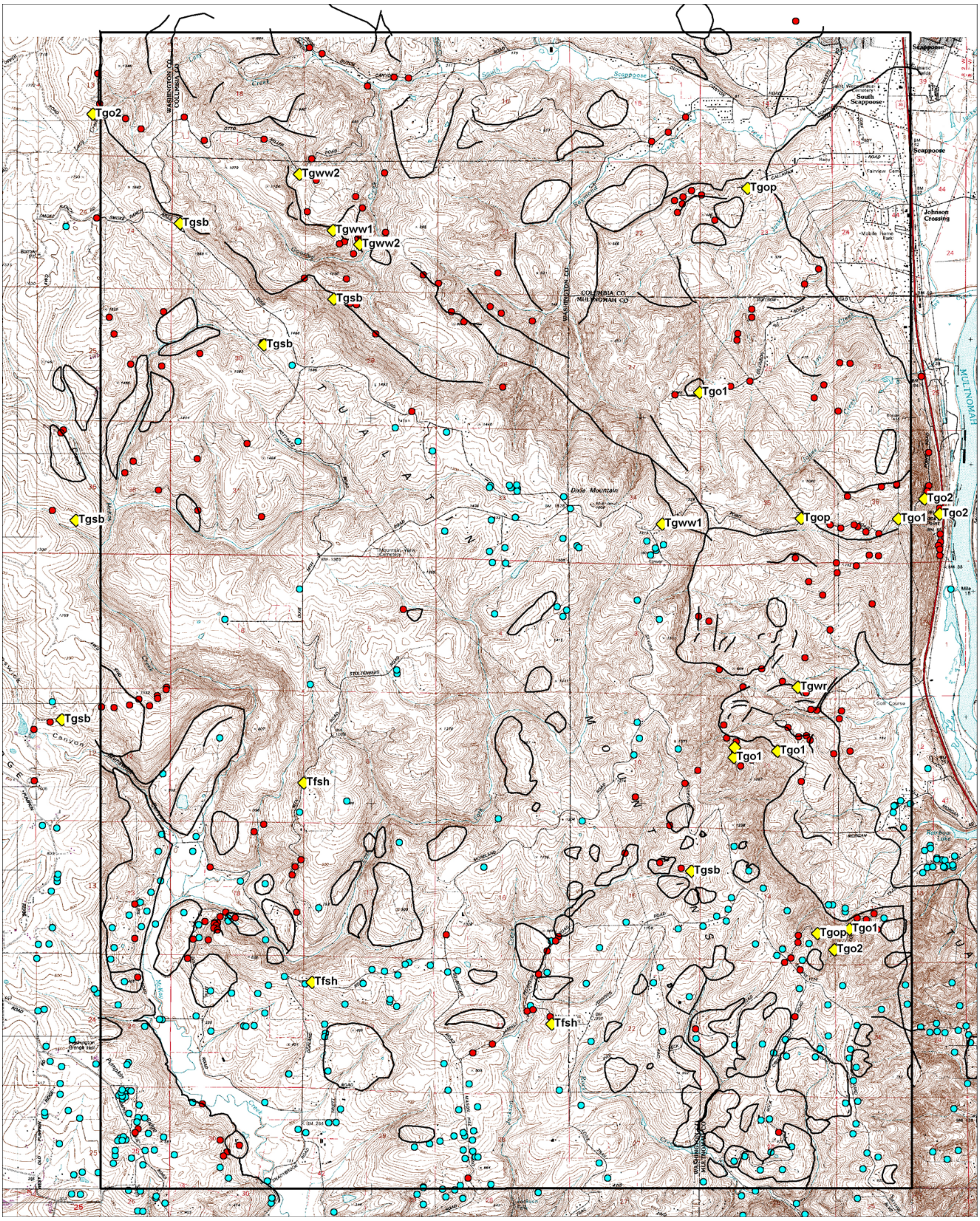


**Figure 3. Progress on the geologic map of the Dixie Mtn Quadrangle**. Blue dots are located water wells (400), red dots field stations (250), yellow diamonds are Columbia River Basalt outcrops analyzed for whole-rock chemistry, labeled with stratigraphic picks. Black lines are mapped contacts (mostly landslide boundaries and scarps); heavy black box is quadrangle boundary.

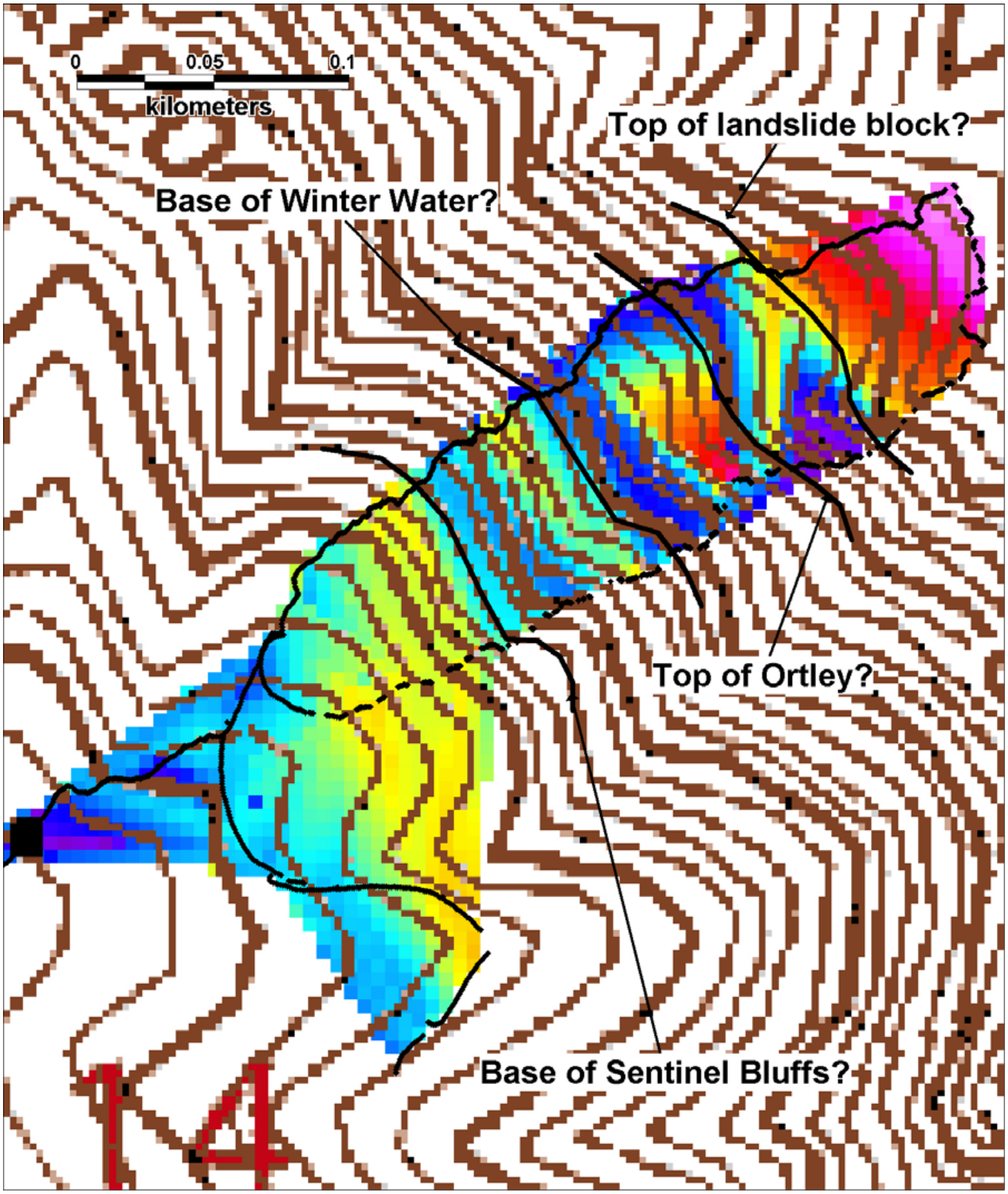


**Figure 4. Dixie Mtn magnetic anomaly map.** Interpolated anomaly map from data points (black diamonds) collected with Scintrex Navmag Cesium Magnetometer, anomaly range is 2000 nT. Inferred contacts of Columbia River Basalt flows shown. Index contours are 100 ft.

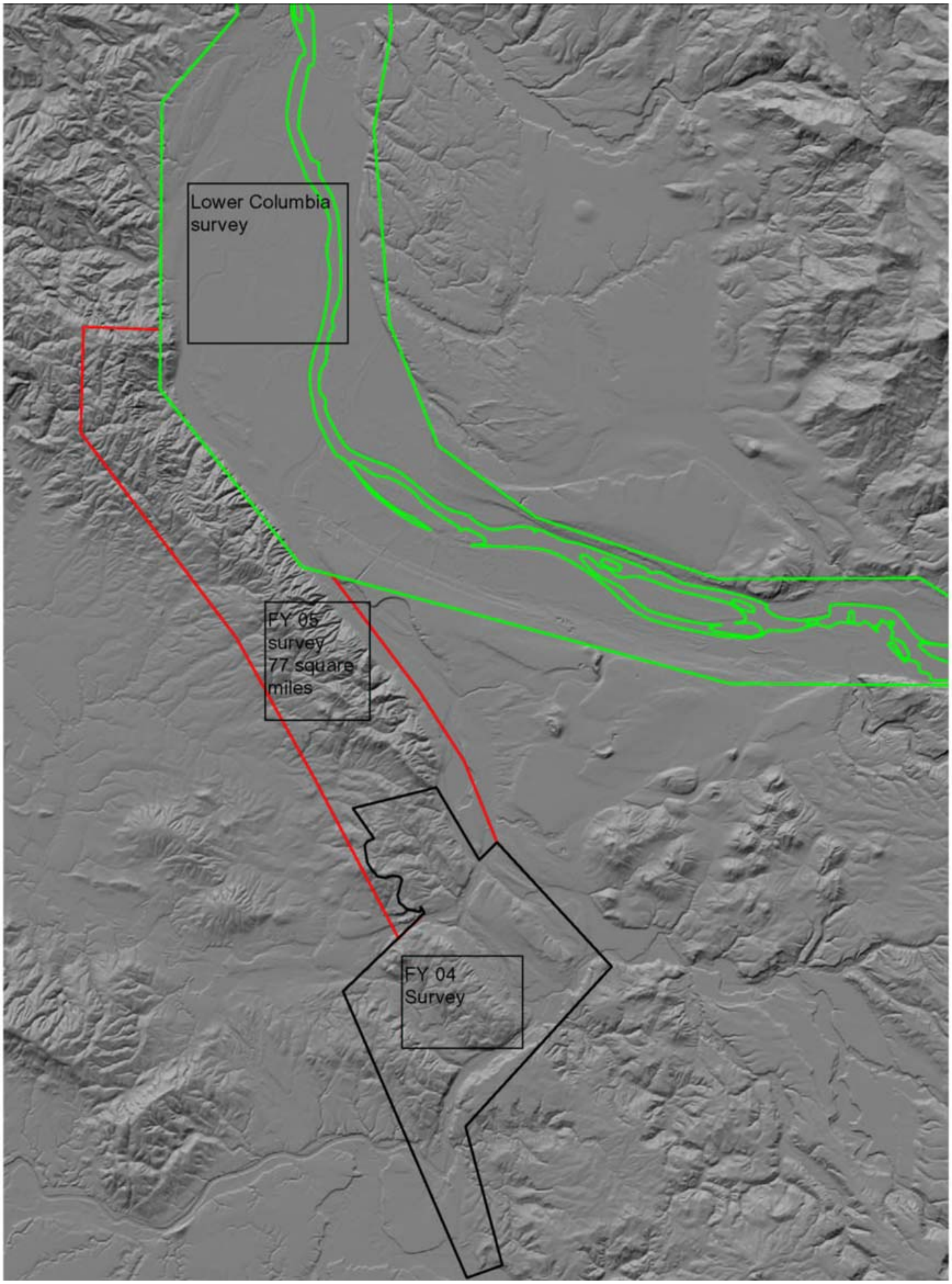


**Figure 5, Lidar survey area**. Figure shows the FY 2005 Lidar survey area in red outline, FY 2004 USGS pilot area in black outline, and USGS FY 2005 Lower Columbia Survey (partial) in green outline.

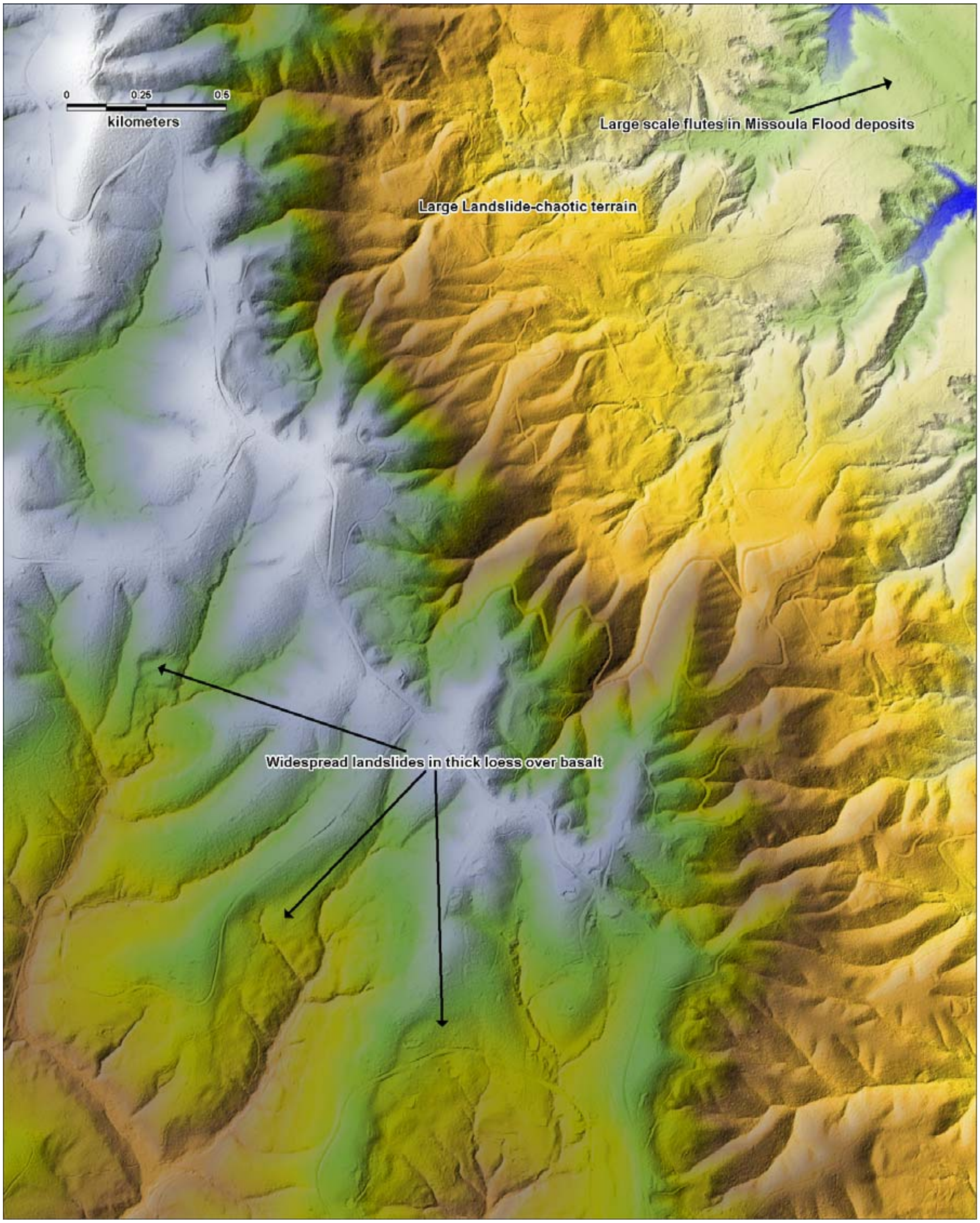


Figure 6, Lidar Image.  Portion of he FY 2005 Lidar data, presented as a color shaded relief map derived from gridding the Lidar data points at 1 m cell spacing.  Note landslide features, large scale sedimentary structures in Missoula Flood deposits.

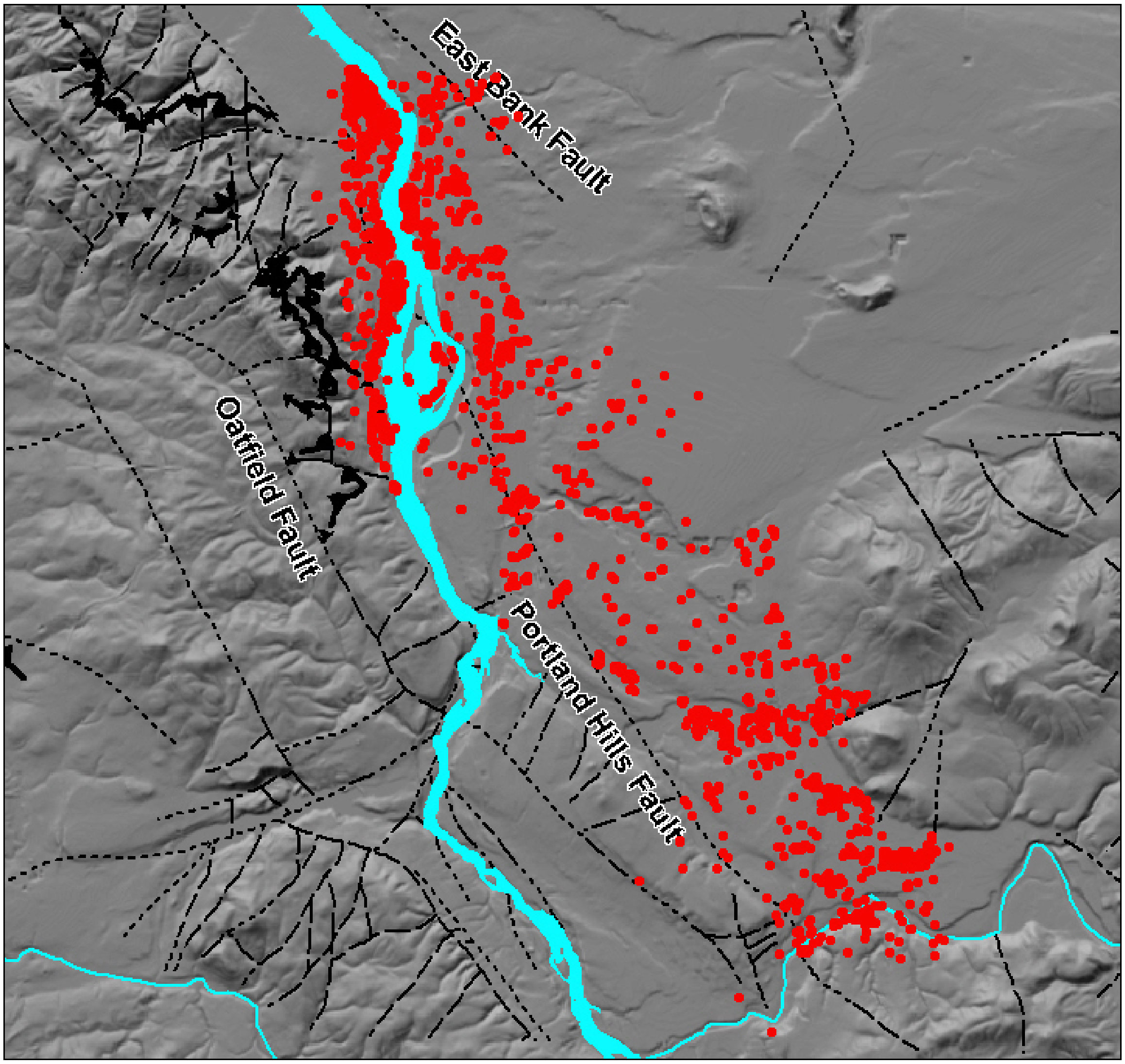


**Figure 1. Located water and engineering borings.** Red dots are 3940 borings located by inspection of online logs in 2004. Dashed lines are mapped faults.

| Project | Specimen | Phenocrysts | Unit | SIO2N | TIO2N | AL2O3N | FE2O3N | FEON | MNON | MGON | CAON | NA2ON | K2ON | P2O5N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PDX | 736 | none | Tgo1 | 55.37 | 1.89 | 13.02 | 8.86 | 3.65 | 0.19 | 3.33 | 6.89 | 2.95 | 1.67 | 0.34 |
| PDX | 719 | none | Tgo1 | 56.27 | 1.99 | 13.56 | 4.05 | 7.34 | 0.17 | 3.22 | 6.71 | 2.79 | 1.75 | 0.34 |
| PDX | 884 | none | Tgo1 | 56.67 | 2.03 | 13.67 | 3.01 | 8.04 | 0.17 | 3.32 | 6.88 | 2.81 | 1.81 | 0.35 |
| PDX | 906 | none | Tgo1 | 55.79 | 2.00 | 13.28 | 3.45 | 8.43 | 0.18 | 3.31 | 6.80 | 2.76 | 1.80 | 0.36 |
| PDX | 799 | none | Tgo1 | 56.35 | 1.98 | 13.35 | 3.46 | 7.40 | 0.19 | 3.55 | 7.30 | 2.89 | 1.69 | 0.36 |
| PDX | 723 | sparse 2-3mm | Tgop | 54.95 | 2.03 | 13.37 | 3.11 | 8.57 | 0.21 | 3.68 | 7.61 | 2.92 | 1.45 | 0.33 |
| PDX | 734 | rare-sparse 2-3mm | Tgop | 56.54 | 1.96 | 13.56 | 2.90 | 7.98 | 0.19 | 3.29 | 6.81 | 2.83 | 1.85 | 0.35 |
| PDX- | 734w | | weathered | 42.43 | 4.53 | 27.36 | 21.49 | 0.48 | 0.08 | 0.38 | 0.40 | 0.23 | 0.05 | 0.40 |
| PDX | 797 | rare 5mm | Tgop | 57.84 | 2.07 | 14.03 | 1.89 | 6.99 | 0.20 | 3.53 | 7.19 | 2.96 | 1.95 | 0.37 |
| PDX | 737 | rare 1 mm | Tgo2 | 55.32 | 1.95 | 13.31 | 3.10 | 8.77 | 0.20 | 3.51 | 7.10 | 3.03 | 1.55 | 0.34 |
| PDX | 721 | rare 5mm | Tgo2 | 55.95 | 1.96 | 13.43 | 4.19 | 7.21 | 0.19 | 3.36 | 7.01 | 2.70 | 1.95 | 0.33 |
| PDX | 792 | none | Tgo2 | 57.46 | 1.91 | 13.83 | 3.37 | 6.60 | 0.16 | 3.21 | 6.94 | 2.82 | 2.00 | 0.35 |
| PDX | 811 | rare 2mm | Tgo2 | 56.10 | 1.93 | 13.56 | 2.89 | 8.17 | 0.19 | 3.49 | 7.17 | 3.00 | 1.71 | 0.35 |
| PDX | 722 | none | Tgww1 | 56.42 | 2.17 | 13.38 | 5.87 | 6.46 | 0.15 | 2.69 | 6.12 | 3.11 | 1.72 | 0.38 |
| PDX | 822 | none | Tgww1 | 57.10 | 2.12 | 14.49 | 4.27 | 5.41 | 0.15 | 3.04 | 6.68 | 3.30 | 1.66 | 0.39 |
| PDX | 733 | rare 1mm | Tgww1 | 57.37 | 2.25 | 13.97 | 4.94 | 5.37 | 0.15 | 2.77 | 6.29 | 3.18 | 1.69 | 0.40 |
| PDX | 908 | abdt 0.5 mm | Tgwr | 56.44 | 2.13 | 13.40 | 2.37 | 8.12 | 0.20 | 3.32 | 6.88 | 2.94 | 2.20 | 0.39 |
| PDX | 934 | abdt 0.5 | Tgwr | 57.30 | 2.15 | 13.39 | 1.87 | 7.94 | 0.22 | 3.32 | 6.83 | 3.03 | 1.92 | 0.37 |
| PDX | 730 | sparse 3mm | Tgww2 | 57.76 | 2.15 | 13.71 | 2.45 | 6.66 | 0.20 | 3.22 | 6.88 | 3.06 | 2.02 | 0.38 |
| PDX | 826 | none | Tgww2 | 57.40 | 2.13 | 14.35 | 5.21 | 5.02 | 0.23 | 3.03 | 6.16 | 3.14 | 1.77 | 0.38 |
| PDX | 788 | | Tgsbmc | 53.90 | 1.99 | 13.59 | 3.74 | 8.10 | 0.21 | 4.02 | 8.65 | 2.70 | 1.23 | 0.35 |
| PDX | 740 | | Tgsbmc | 54.60 | 2.02 | 14.15 | 2.03 | 7.89 | 0.19 | 4.25 | 8.80 | 2.89 | 1.28 | 0.35 |
| PDX | 727 | | Tgsbmc | 54.33 | 1.96 | 13.79 | 2.06 | 8.70 | 0.21 | 4.32 | 8.71 | 2.77 | 1.28 | 0.34 |
| PDX- | 727w | | weathered | 40.42 | 4.15 | 28.21 | 21.96 | 1.37 | 0.33 | 0.55 | 0.34 | 0.23 | 0.08 | 0.50 |
| PDX | 795 | | Tgsbmc | 53.14 | 1.93 | 13.26 | 3.09 | 9.56 | 0.23 | 4.69 | 8.29 | 2.81 | 1.09 | 0.34 |
| PDX | 805 | | Tgsbmc | 54.83 | 2.04 | 14.23 | 2.51 | 7.19 | 0.18 | 4.15 | 8.79 | 2.89 | 1.31 | 0.36 |
| PDX | 818 | | Tgsbmc | 54.16 | 2.01 | 13.76 | 3.15 | 8.49 | 0.21 | 4.13 | 8.59 | 2.79 | 1.22 | 0.35 |
| PDX | 756 | | Tfsh | 51.04 | 2.94 | 12.77 | 2.53 | 11.70 | 0.23 | 4.39 | 8.13 | 2.68 | 1.25 | 0.57 |
| PDX | 771 | | Tfsh | 50.69 | 2.97 | 12.73 | 3.84 | 10.42 | 0.34 | 4.42 | 8.21 | 2.58 | 1.23 | 0.56 |
| PDX | 706 | | Tfsh | 51.42 | 2.80 | 12.70 | 3.16 | 11.00 | 0.23 | 4.21 | 8.10 | 2.61 | 1.18 | 0.57 |

**Table 1. Whole Rock Geochemisty of Columbia River Basalt**. XRF analyses by Dr. Stan Mertzman of Franklin and Marshall College, normalized. Tgo are flows of Ortley, Tgww are flows of Winter Water, Tgwr are flows of Wapshilla Ridge, Tgsbmc are flows of Sentinel Bluffs and Tfsh are flows of Sand Hollow.